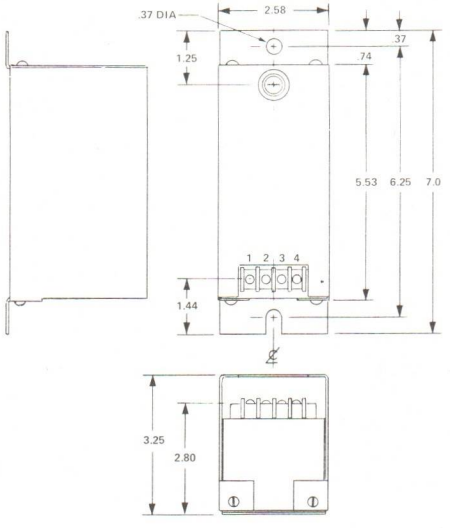
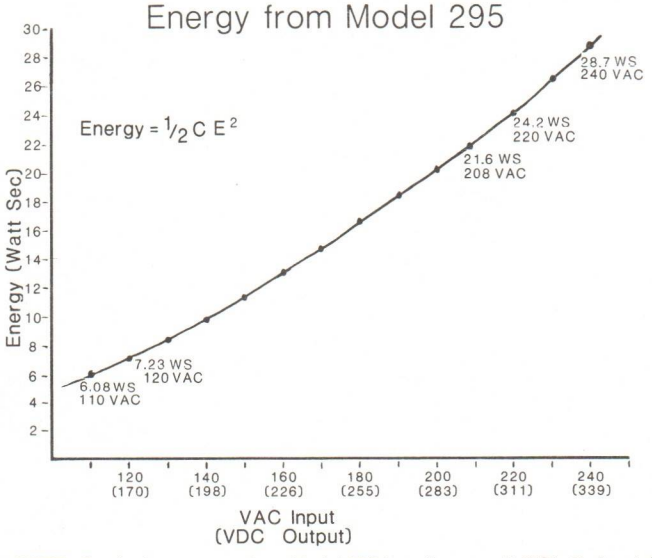
# MODEL 295

# CAPACITOR TRIP DEVICE

## STORED ENERGY FOR USE WITH SHUNT TRIP BREAKERS

## DIMENSIONS



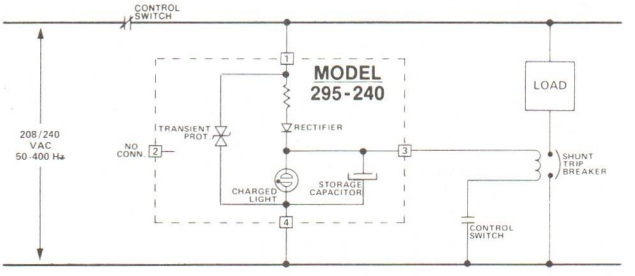




**NOTE**: Graph shows energy from Model 295 in watt-second (WS). Horizontal axis represents the input (VAC) voltage with the corresponding output (VDC) voltages.

## DESCRIPTION

The capacitor trip device is used for tripping circuit breakers from an AC voltage source by using the stored energy in a capacitor. The capacitor is constantly kept at full charge during normal operation by a half-wave silicon rectifier which is turn draws its energy from the 208 / 240 volt line. When completely discharged, the device will draw approximately 10 amps from the line during the first half cycle, 3 amps the second half cycle, 1 amp the third. Continuous current required to keep the capacitor charged is less than 5 milliamps. The capacitor will hold sufficient charge to trip the breaker at least 12 seconds after charging voltage is completely removed. However, on most fault conditions, some voltage is still present, and the device is so designed that 65% of normal voltage will give sufficient charge to trip the breaker at any time. A low-energy glow lamp is connected in parallel with the storage capacitor to give a visual indication when the voltage charge is 85 volts or more. If the charging voltage is removed, it will require approximately 5 minutes for the device to self bleed to the 85 volt level. Can be used as is on most 120 VAC applications The Model 295 can be discharged manually or by means of a voltage sensor or phase loss monitor.

## WIRING DIAGRAM FOR TYPICAL TRIPPING CIRCUIT




* Contact shown under operating conditions

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|---|---|
| TITLE: MODEL 295 Capacitor Trip Device | Unless Otherwise Specified Dimensions Are In Inches Drawings Show No Power Applied |
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# MODEL 410

## AUTO- CHARGED

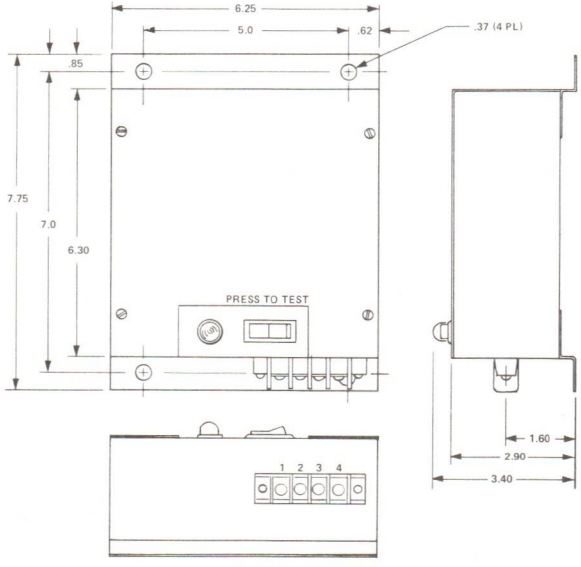
# CAPACITOR TRIP DEVICE

- For use with shunt- trip breakers and lock- out relays
- Self contained standby power source
- Will hold charge for a minimum of 5 days

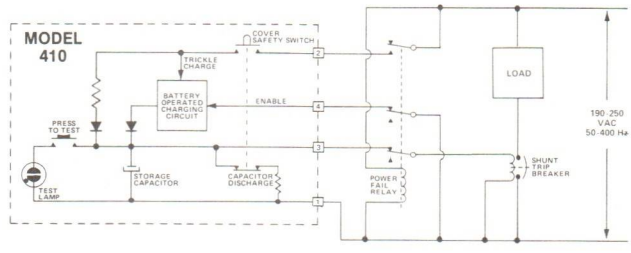
## DESCRIPTION

The auto charged trip device is a high- speed capacitor- type circuit breaker tripping unit. It differs from the conventional capacitor trip device in that it has a self- contained, standby power source which is capable of maintaining full operating voltage for several days. The device is primarily for use with circuit breakers which require some form of AC power for their closing operation, i.e., circuit breakers having either a stored energy closing mechanism with an AC operated release coil or an AC solenoid operated closing mechanism. There are no field adjustments required on the unit and the device contains a cover- actuated safety switch which discharges the capacitor and disconnects the primary source when the cover is removed. The device can be tripped manually or by means of a voltage sensing or phase loss monitor.

## DIMENSIONS




## TYPICAL APPLICATION




## ORDERING INFORMATION

| Model | | Voltage |
|---|---|---|
| 410 | -- | 240V |

Note: 120 V versions are available on request.

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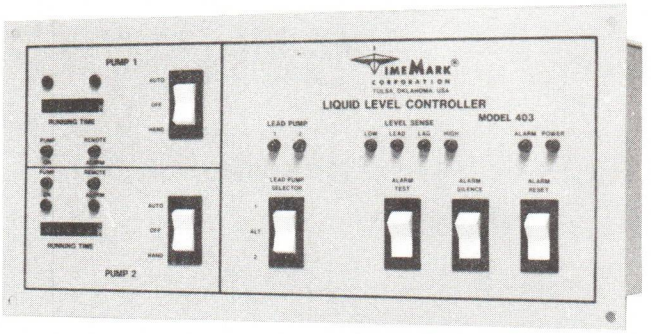
## Model 403

# LIQUID LEVEL CONTROLLER




- **Dual run-time meters**
- **Selectable lead / lag or automatic alternation**
- **Alarm outputs**
- **Hand-off-auto controls**
- **4 sensing levels**
- **Moisture protected circuits**

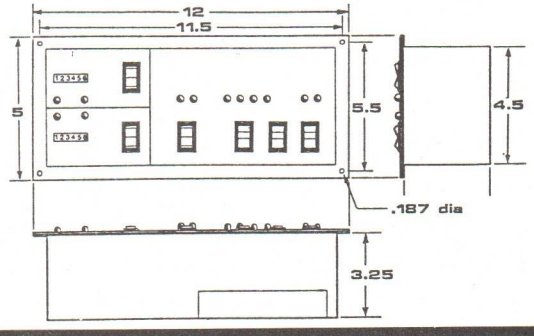
## DESCRIPTION

The 403 Liquid Level Controller provides central control of duplex pumping systems. The Model 403 includes pump alternating, visual run-time meters, hand-off-auto control and alarm outputs. Four level-sense inputs interface with float switches or other level sensing devices which can provide a contact closure.

## OPERATION

The first level (Low) stops both pumps as the level drops below this point, and triggers alternating. The second level (Lead) starts one pump as the liquid rises to close this circuit. Which pump starts at this level is determined by the Lead Pump Selector switch on the face of the 403. The third level (Lag) causes both pumps to run as the liquid level rises to this point. The fourth level (High) illuminates the alarm indicator and closes the alarm bell and alarm light outputs. An 'Alarm Silence' switch opens the alarm bell contacts, stopping the alarm. An 'Alarm Reset' switch opens the alarm light contacts and extinguishes the alarm indicator on the 403 front panel. A SPST normally-closed internal power fail contact opens when 120 VAC power is connected to the 403, and closes if power is lost or removed. Connections for external remote alarm contacts, which must remain closed for normal operation, are supplied for each pump. If either circuit opens, the corresponding pump will be locked out until the problem is corrected and the 'Alarm Reset' switch is pressed.

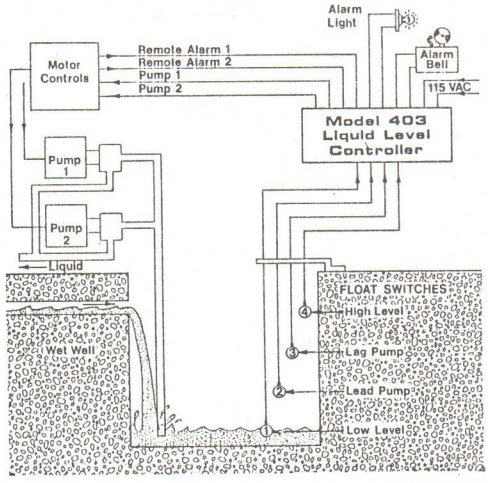
## DIMENSIONS




## SPECIFICATIONS

| | |
|---|---|
| Input voltage | 105-130 VAC |
| Input frequency | 47-65 Hz |
| Power consumption | 10 Watts max |
| Contact rating | 10 amps at 240 VAC resistive |
| Transient protection | 2500 VRMS for 10 ms |
| Operating temperature | -20 to 60° C |
| Case material | 20 ga steel |
| Float switch potential | 12 VDC AT .001 amps |
| Display | to 99,999.9 non-resettable |
| Humidity tolerance | 0-97% w/o condensation |
| Weight | 4.9 lbs max |

## TYPICAL APPLICATION





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| | |
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| TITLE MODEL 403 LIQUID LEVEL CONTROLLER | Dimensions are in inches unless otherwise specified. Drawings show no power applied. |
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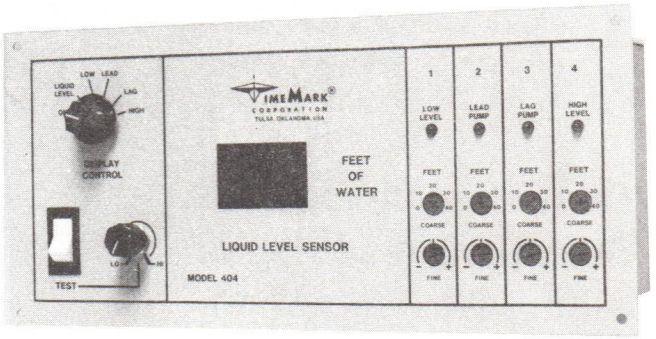
# Model 404
# LIQUID LEVEL SENSOR

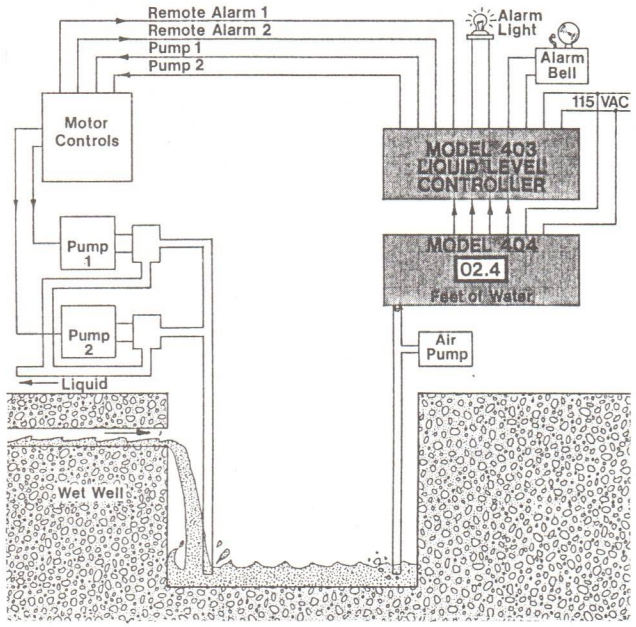



- **Digital display of water depth**
- **Internal transducer**
- **5 adjustable trip points**
- **4-20 ma output**
- **Moisture protected circuits**

## DESCRIPTION

The Model 404 Liquid Level Sensor operates in conjunction with a Model 403 Controller for bubbler-type duplex pumping systems. The 404 contains an air pressure-to-voltage transducer and requires only a small air compressor capable of 15 psi (pounds per square inch) to operate the system down to approximately 35 feet. The Sensor's four outputs are designed to replace the float switch inputs to a Model 403, or to be used with a Model 448 Output Relay Board. A 4-20 ma signal output provides for other control applications. A 3-digit LED display continuously shows the liquid level to a tenth of a foot when the Display Control switch is in the Liquid Level position. Other settings of the switch allow setting of the liquid level trip points. Indicator LEDs illuminate as the levels are exceeded. A test control allows the trip settings to be checked without actually raising or lowering the liquid level.

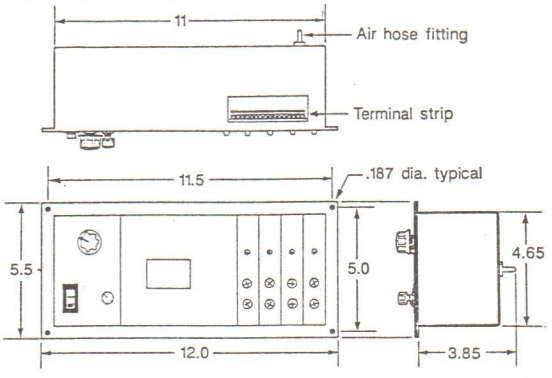
## TYPICAL APPLICATION




## SPECIFICATIONS

| | |
|---|---|
| Input voltage | 105-130 VAC |
| Input frequency | 47-65 Hz |
| Power consumption | 2 Watts |
| Transient protection | 2500 VRMS for 10 ms |
| Air pressure input | 0 to 15 psi max |
| Input air supply fitting | requires $^3/_{16}$" I.D. tubing |
| Maximum liquid level displayed | 34.6 feet |
| Calibration accuracy | ± 2% |
| Repeat accuracy (fixed condition) | ± 1% |
| Repeat accuracy (0-60° C) | ± 2% |
| Dead band | 0.1 foot |
| Switching outputs | 4 open-collector transistors used as inputs for the Model 403 or with the Model 448 Output Relay Board |
| Signal outputs | 4-20 ma output proportional to 0-40 feet of water |
| Operating temperature | -10 to 50° C |
| Storage temperature | -20 to 70° C |
| Humidity tolerance | 0-97% w/o condensation |
| Case material | 20 ga steel |
| Termination | terminal strip |
| Weight | 3.5 lbs |

## DIMENSIONS

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|---|---|
| TITLE MODEL 404 LIQUID LEVEL SENSOR | Dimensions are in inches unless otherwise specified. Drawings show no power applied. |
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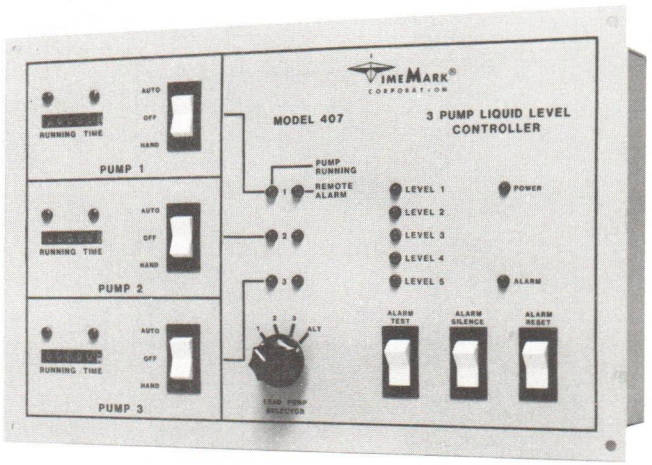
## Model 407

# LIQUID LEVEL CONTROLLER




- 3-Pump operation
- 3 Run time meters
- Selectable lead pump or automatic alternation
- 5 sensing levels
- Alarm outputs
- Moisture protected circuits

## DESCRIPTION

The 407 3-Pump Liquid Level Controller provides central operating control of triplex pumping systems. The solid-state electronic Controller provides alternating of load pumps, low level cutoff and high level alarm outputs. Run-time meters provide instant visual data on total running time of each pump motor. Indicator LEDs show ON/OFF status of each pump.

## OPERATION

The 407 has five level-sense inputs which can be activated by float switches or other level sensing devices which provide a switch closure. Level 1 (Low) will turn off all pumping action and trigger the alternator. Level 2 (Lead) turns on whichever pump is selected (automatically or manually) as the lead pump. Levels 3 and 4 (Lag and Lag-lag) turn on the second and third pumps. Level 5 (High) is a high level alarm which closes two output contacts for audible and visual alarms.

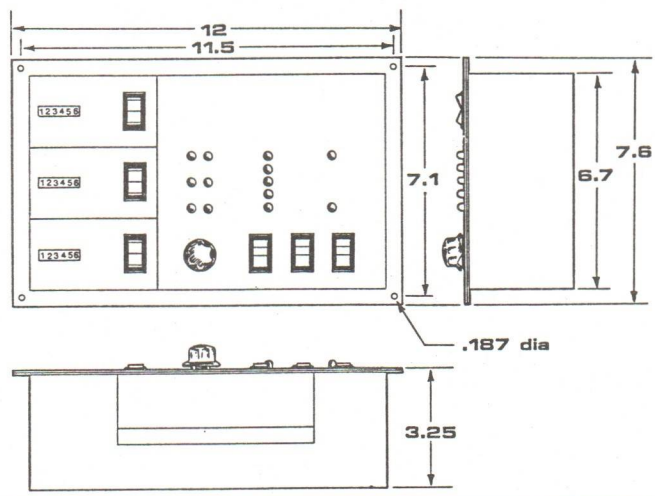
## ALARMS

When the 5th level is reached two alarm contacts (bell and light) trip and an alarm light on the panel will illuminate. A front panel switch allows the alarm to be silenced, leaving the alarm light output tripped. An alarm reset on the front panel resets all outputs after the fault is corrected. Remote alarm circuits - provided for each pump - control pressure switches, temperature switches or other monitoring controls. These circuits are normally closed and will inhibit the corresponding pump when opened, illuminated a remote alarm light on the 407's panel, and close the alarm light and bell contacts. A SPST normally-closed internal power fail contact opens when 120 VAC power is connected to the 403, and closes if power is lost or removed.

## SPECIFICATIONS

| | |
|---|---|
| Input voltage | 105-130 VAC |
| Input frequency | 47-65 Hz |
| Power consumption | 10 Watts max |
| Contact rating | 10 amps at 240 VAC resistive |
| Transient protection | 2500 VRMS for 10 ms |
| Operating temperature | -20 to 60° C |
| Case material | 20 ga steel |
| Float switch potential | 12 VDC AT .001 amps |
| Display | to 99,999.9 non-resettable |
| Humidity tolerance | 0-97% w/o condensation |
| Weight | 6.1 lbs max |

## DIMENSIONS

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TITLE MODEL 407 LIQUID LEVEL CONTROLLER

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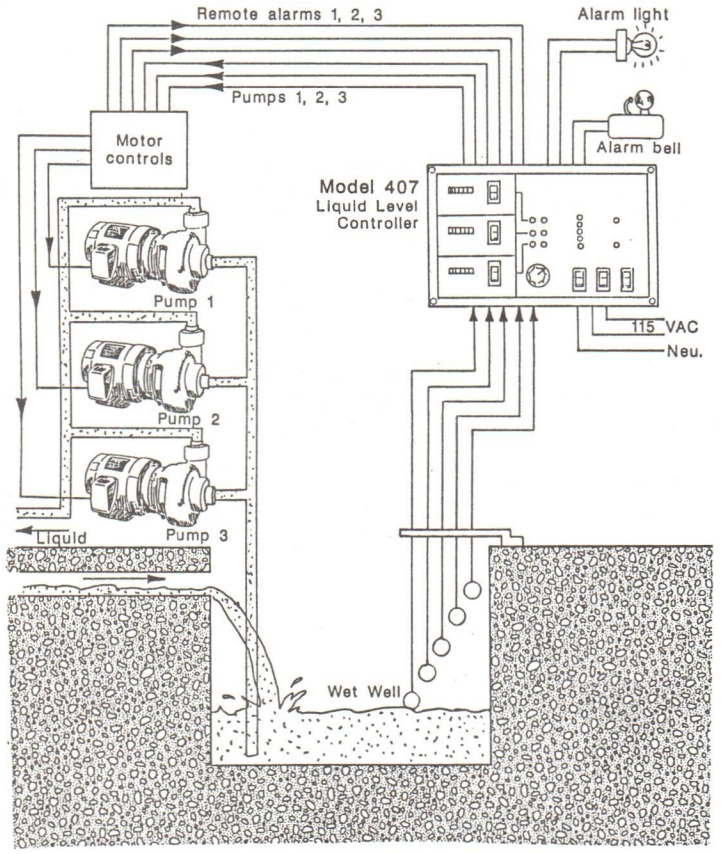
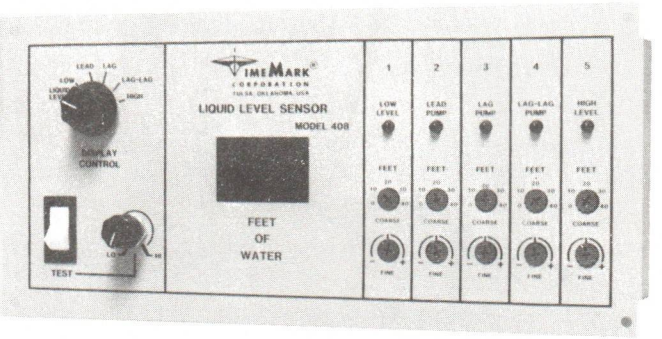
# TYPICAL APPLICATION



## Model 408

# LIQUID LEVEL SENSOR




- **Digital display of water depth in feet**
- **Self contained transducer**
- **5 adjustable trip points**
- **Solid-state outputs**
- **4 - 20 ma output**

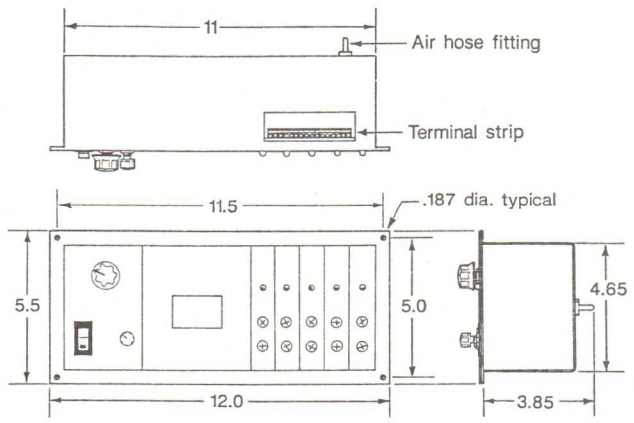
## DESCRIPTION

The Model 408 is a 5-level liquid level sensor designed for use with bubbler-type systems. The 408 contains an internal air pressure transducer; the user must provide a small air compressor capable of supplying a maximum of 15 psi. This will operate the system to a liquid depth of 34.6 feet. The output of the 408 connects to the inputs of the Model 407 3-Pump Liquid Level Controller (replacing the float switches) or to a Model 448 Output Relay Board. Also, a 4-20 ma signal output is provided as an input to process controllers or for other control applications. A 3-digit LED display continuously shows the liquid depth to a tenth of a foot when the display control switch is in the 'Liquid Level' position. Other switch positions allow the setting of the corresponding trip level points. The trip points are set using coarse and fine adjustment pots, and are shown on the LED display. Each trip level has an LED indicator which illuminates as the solid-state output makes. A test feature allows the trip settings to be checked without actually changing the liquid level.

## SPECIFICATIONS

| | |
|---|---|
| Operating voltage range | 105 to 135 VAC |
| Frequency range | 47 to 65 Hz |
| Power consumption | 2.5 Watts Max. |
| Transient protection | 2500 VRMS for 10 ms |
| Air pressure input | 0 to 15 PSI Max. |
| Input air suppy fitting | requires $^{3}/_{16}$" I.D. tubing |
| Maximum liquid level displayed | 34.6 feet |
| Calibration accuracy | ± 2% |
| Repeat accuracy (fixed conditions) | ± 1% |
| Repeat accuracy (0 - 60 deg. C) | ± 2% |
| Dead band | 0.1 foot |
| Switching outputs | 5 open-collector transistors used as inputs for the Model 407 or with the Model 448 Output Relay board |
| Signal output | 4-20 ma output proportional to 0-40 feet or water |
| Operating temperature range | -10 to 50° C |
| Storage temperature range | -20 to 70° C |
| Humidity tolerance | 97% w/o condensation |
| Case | 20 Ga. CRS |
| Termination | Terminal strip |
| Weight | 3.5 lbs. |

## DIMENSIONS

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TITLE MODEL 408 LIQUID LEVEL CONTROLLER

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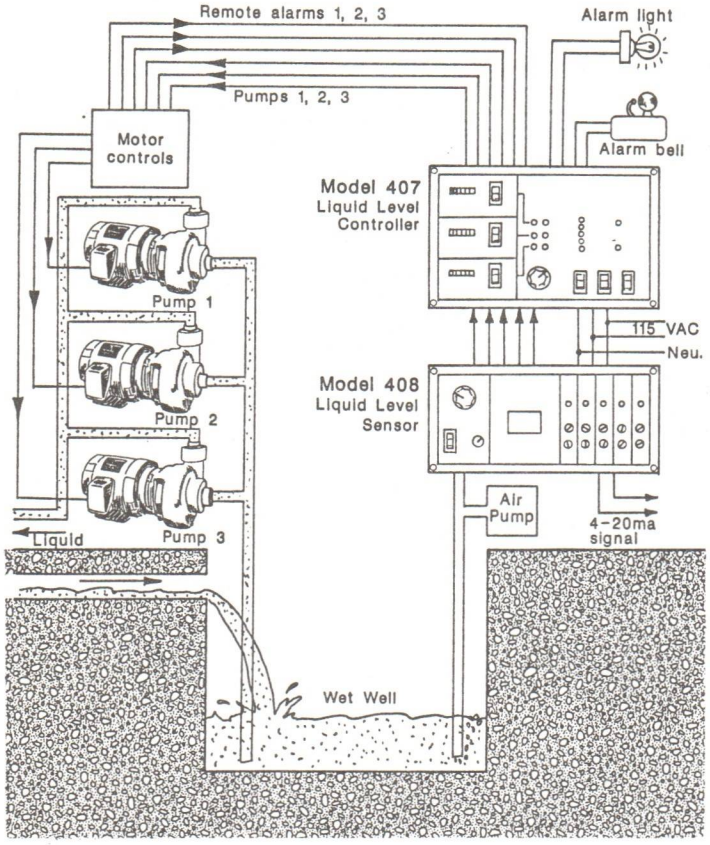
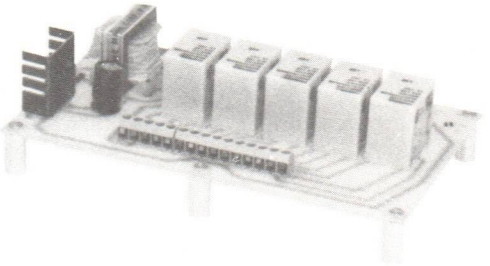
## TYPICAL APPLICATION



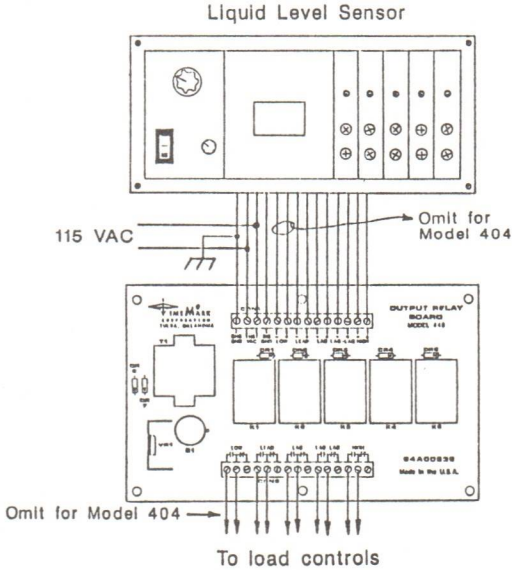



## Model 448

# OUTPUT RELAY BOARD

### • For use with Models 404 and 408

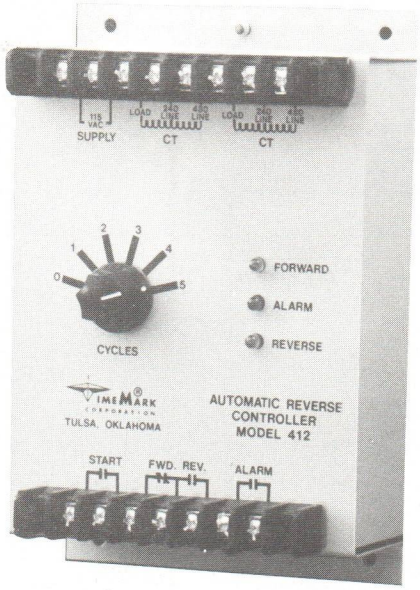
The Model 448 Output Relay Board provides relay contacts for a Model 404 or 408 Liquid Level Sensor, allowing the Sensor to be used as a control device. The 448 consists of a power supply and five relays on a surface-mounted printed-circuit board. Four of the five relays are used with the Model 404: the input and output terminals marked "low" are not used. All five relays are used with the Model 408. The Model 448 uses the solid-state outputs of the 404/408 as inputs to control the 448's relays.




### SPECIFICATIONS

| | |
|---|---|
| Input voltage | 105 to 135 VAC |
| Input frequency | 47 to 65 Hz |
| Power consumption | 1.5 Watts |
| Inputs | Solid-state from Models 404 or 408, or any contact closure |
| Outputs | 5 SPDT |
| Output rating | 4 amps at 120 VAC resistive |
| Dimensions | 7" x 4.25" x 2" H |
| Mounting dimensions | 6.625" x 3.875" |
| Weight | 12.5 oz |

# Model 412
# AUTOMATIC REVERSE CONTROLLER




- **Controls sewage grinders**
- **Up to 5 forward / reverse cycles**
- **LED indicator lights**
- **Direct current inputs up to 2 HP**

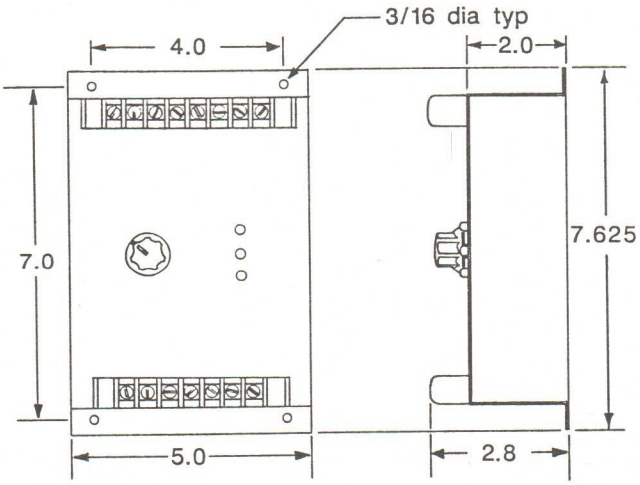
## DESCRIPTION

The Model 412 Automatic Reverse Controller is a current sensor to detect jamming of sewage grinders and initiate the reversing of the grinder. The controller is selectable for up to five forward/reverse cycles in any 30-second period, and provides an alarm output if the number of cycles is exceeded. The current loop inputs are designed for direct connection of 10 amp, 240VAC, or 5 amps, 480VAC (motors up to 2 hp). For higher currents, CT's must be used (the CT secondaries are connected to the 5 amp terminals, regardless of voltage). Indicator lights show running direction of the motor and the alarm condition.

## OPERATION

When operating in the forward mode, an over current condition causes the START contact to open for 1/2 second. The FWD/REV contact switches to REV and the START contact recloses. Three seconds later, the START contact opens and the FWD/REV contact switches to FWD. If the over current condition persists, this sequence repeats for the number of cycles selected. After the last cycle, the START contact opens and the ALARM contact closes. The controller is locked out and must be reset by removing and reapplying the operating voltage.

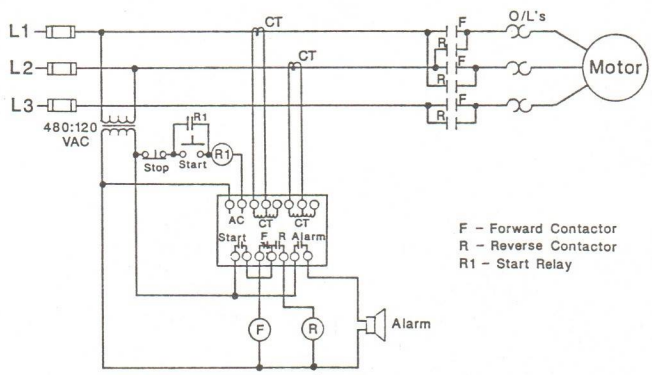
## DIMENSIONS




## SPECIFICATIONS

| | |
|---|---|
| Operating power | 115VAC, 50/60Hz |
| Input currents | 5 amps at 480VAC, 3-phase<br>10 amps at 240VAC, 3-phase |
| Transient protection | 2500VRMS for 10ms |
| Number of cycles | 0-5 cycles |
| Cycle period | 30 seconds |
| Reverse cycle time | 3 seconds |
| Output contacts | 2 amps at 115VAC |
| Expected relay life: | |
| Mechanicals | 50,000,000 operations |
| Electrical | 100,00 at rated load |
| Operating temperature | -20 to +60° C |
| Humidity tolerance | 0-97% w/o condensation |
| Case material | 20 ga CRS |
| Weight | 2.3 lbs. |

## TYPICAL APPLICATION





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|---|---|
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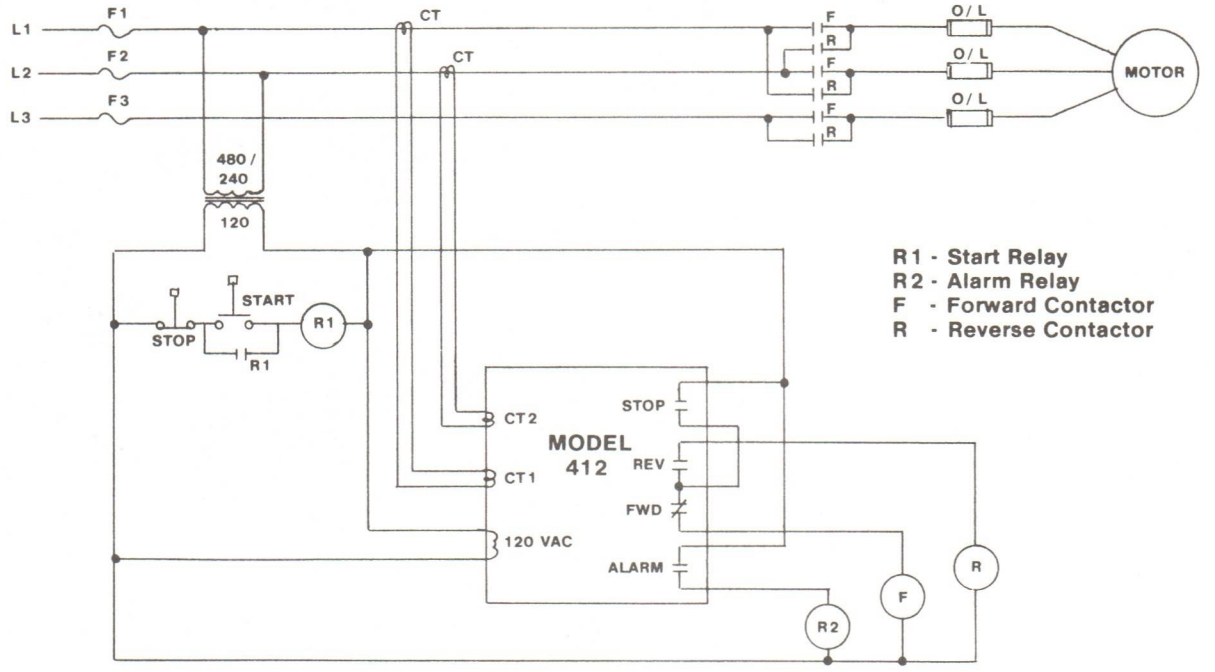
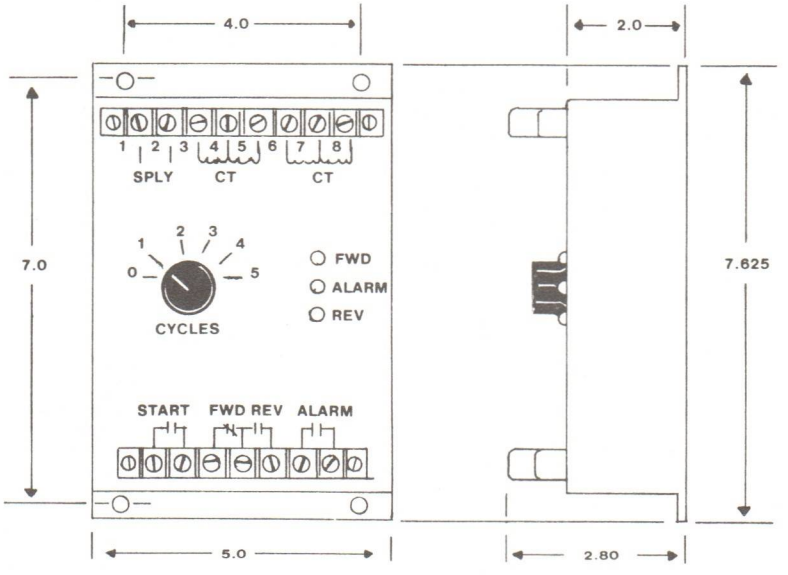
# APPLICATION




# DIMENSIONS





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TITLE: MODEL 412
Auto Reverse Controller

Unless Otherwise Specified
Dimensions Are In Inches
Drawings Show No Power Applied

DRAWING NUMBER: 87 - A - 125

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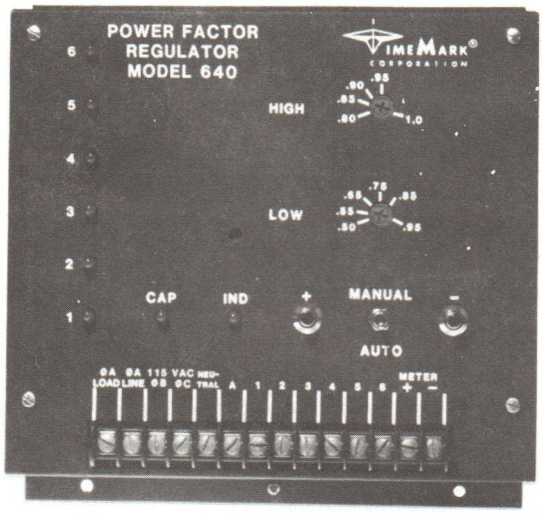
## MODEL 640

# POWER FACTOR REGULATOR

- High Accuracy Phase Angle Sensing Design
- Adjustable Limits
- Automatic / Manual Modes
- LED's Show Activated Steps And Capacitive- Inductive Status




## DESCRIPTION

The Model 640 Power Factor Regulator is the monitoring and control portion of a power factor correction system. The 640 uses a unique phase-angle sensing circuit to monitor the power factor of a 3-phase power line.

In its automatic mode the 640 responds by closing or opening internal relays, adding or subtracting capacitor banks on the line. When the 640 is in the manual mode capacitance can be removed or added at the push of a button.

Two adjustments set the point at which the relays begin to close (0.5 to 0.95) and stop (0.8 to 1.0). 'LOW' is the point at which capacitors are added, at 40-second intervals, until the power factor reaches the 'HIGH' point. If the power factor is over compensated, capacitors are removed until a factor of 1.0 is achieved. If the operating voltage is lost or the input current is too low, all relays will drop out.

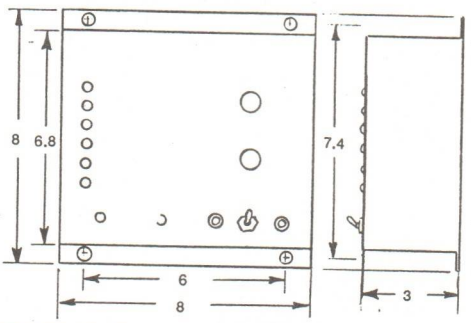
Indicator lights on the face of the 640 show if the system is inductive or capacitive. Output lights show relay status. An output is provided to drive a 1 mA DC meter (available separately). Center scale on the meter will indicate a power factor of 1.0; a left deflection will indicate a capacitive power factor, while a right deflection will indicate an inductive power factor. Use of an external meter is optional.

Although intended for 3-phase, 115vac, 60 Hz systems, other voltage or frequency models may be available.

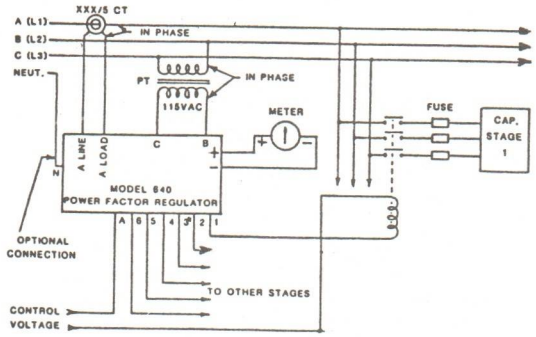
## SPECIFICATIONS

Input Voltage ..... 115 VAC, 60 Hz
Input Current ..... Min: 0.25 to 1 A adj.
Max: 10 A continuous
Output Contacts..... 2 A at 115 VAC
Time Delay..... 40 Seconds Between Steps

## DIMENSIONS




## APPLICATION

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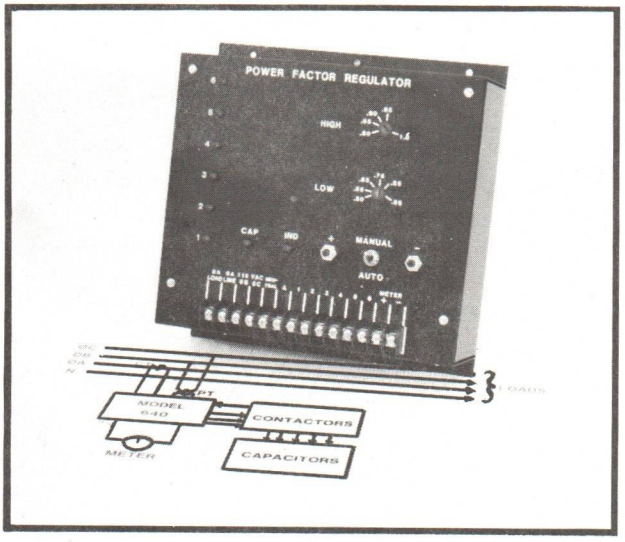
# MODEL 640

# POWER FACTOR REGULATOR

## Application Notes




Correction of low power factor by addition of capacitors in parallel with inductive loads is a well known and proven technique.

The savings in actual power cost can be significant; however, there are many cases where the savings in new wiring and equipment can overshadow the actual power cost savings.

The power factor is always stated in a decimal number between 0 and 1 and is the cosine of the angle between the voltage and current wave forms. In Alternating Current circuits, power ( watts) is defined as voltage x current x power factor. From this, it is easily seen with a power factor of 1 power is voltage x current and with a power factor of 0 there can be no power regardless of how large the voltage or current may be.

A normal inductive motor will have a power factor between .30 and .90 depending upon how the motor is loaded. A motor operating at its rated load will have an improved( higher) power factor than the same motor which is very lightly loaded. Transformer load also has a bearing on the power factor. Many other normal items located in industrial plants contribute to the low power factors.

The direct cost of a low power factor usually shows up on the monthly bill as an extra charge.

The indirect costs are the heavier wiring required or the larger transformer needed. As an example: in a plant which requires 500 KW of power the transformer must be:

500 KVA at 1.00 Power Factor
625 KVA at .80 Power Factor
1000 KVA at .50 Power Factor

Likewise, the feeder wiring to this same plant requiring 500 KW at 480 volts would need to be of a larger size. The current carrying capacity of the wire would be:

1042 AMPS at 1.00 Power Factor
1302 AMPS at .80 Power Factor
2083 AMPS at .50 Power Factor

These figures can easily be related to wire size and cost. In each of these examples, the end result is the same amount of power delivered to the load.

The addition of power factor correction capacitors is accomplished in many ways. The most efficient means would be to correct every load to a 1.00 power factor while it is operating by switching in capacitors with the load; however, this is rarely practical. In general, motors of 10 HP or more are corrected individually and smaller motors are corrected in groups.

There are also conditions where motors operate at varying loads and at varying times.

The Time Mark Model 640 Power Factor Regulator was designed to help obtain an improved power factor with a minimum of added capacitors. This unit monitors the power line and adds or subtracts six separate capacitor stages according to the power factor.

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TITLE: Model 640 App. Notes 11/84

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DRAWING NUMBER:

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The Model 640 has a low power factor control adjustable between .50 and .95. if the power factor drops below this setting, the unit will begin adding stages of capacitors each 40 seconds until the high power factor setting is reached. The high power factor is adjustable between .80 and 1.00 and should always be set higher than the low setting.

The unit will drop out one stage of capacitors every 40 seconds if the power factor changes to capacitive, or leading. This will continue until the power factor is inductive, or lagging.

There is one unmarked adjustment which can be considered a current threshold. This adjustment is to set the point where the unit will disconnect all of the capacitors. This current threshold is adjustable between 0.25 and 1.00 Amp from the current transformer. An example of the use of this control could be in a building where the total night load dropped to some low level and the addition of one stage of capacitor would cause a wide fluctuation of the power factor or an oscillating condition. This threshold sets the point below which the unit is inoperative.

A power loss to the Model 640 will also cause all capacitors to be disconnected.

The Model 640 may be operated in a manual mode. Capacitor stages can be added or subtracted with push button control.

A meter signal is provided on the Model 640 for a DC meter with a 0 - 1 milliamp movement. the meter calibration will be:

0.1 MA = 0.50 Power Factor - Capacitive
0.5 MA = 1.00 Power Factor
0.9 MA = 0.50 Power Factor - Inductive

Power Factor correcting capacitors and capacitor banks are normally rated in KVARS. To properly size the capacitors to a given application there are three basic steps.

1. Determine present load, measured in KW
2. Determine present power factor
3. Determine desired power factor

The meter output is nonlinear; i.e.
1.00 pf = .5 maDC, .5 pf = .09 maDC
Refer to Chart 1 for details.

Using Chart 2, in the vertical LH margin locate the original ( present) power factor, then across the top of the chart locate the corrected ( desired) power factor. Where the column and row of these two figures intersect, note the correction factor, which is a three- place decimal number.

The correction factor is then multiplied by the present KW load. The result of this is the capacitor size required, stated in KVAR. Correcting to a power factor of .95 is generally considered optimum and correcting to a leading, or capacitive, condition should not be attempted. When the total KVAR requirement is determined, this size can be divided between the six stages of the Model 640 to provide a six- step power factor correction.

When installing capacitors, consult the manufacturer's literature for fusing and contactor requirements.

In addition to the capacitors and contactors, a properly sized current transformer with a minimum burden rating of 2 VA and a 5 Amp secondary is required, and a power transformer with a 115 VAC secondary at 50 VA minimum. Proper phasing of the CT and PT is essential. If correction stages work in reverse, disconnect power and reverse CT secondary leads. A simple diagram is shown below.

**TYPICAL CONNECTION DIAGRAM**

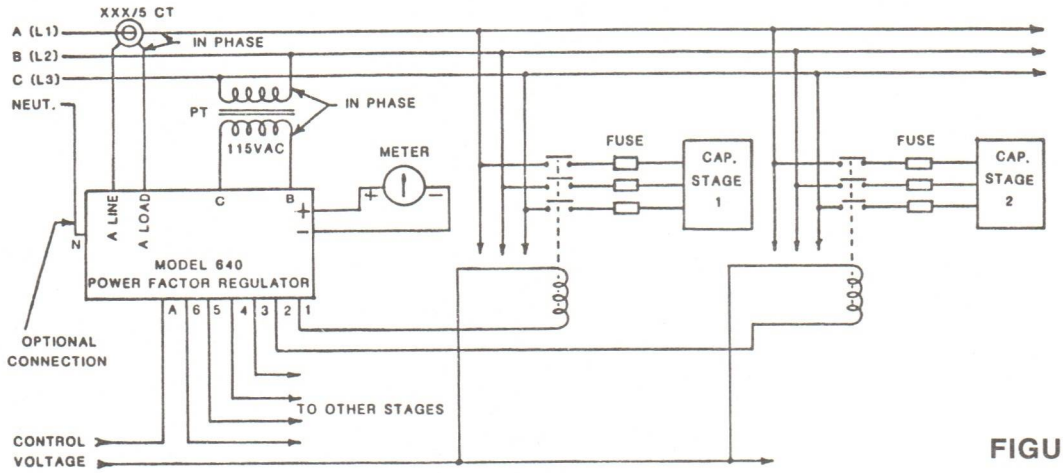



**FIGURE 1**

CHART 1

# METER READINGS VS. POWER FACTOR

| POWER FACTOR | CAPACITIVE OUTPUT ( IN mA) | INDUCTIVE OUTPUT ( IN mA) |
|---|---|---|
| 0.40 | 0.0571877 | 0.942812 |
| 0.45 | 0.0782908 | 0.921709 |
| 0.50 | 0.0999998 | 0.900000 |
| 0.55 | 0.122446 | 0.877554 |
| 0.60 | 0.145799 | 0.854201 |
| 0.65 | 0.170277 | 0.829723 |
| 0.70 | 0.19618 | 0.80382 |
| 0.75 | 0.223936 | 0.776064 |
| 0.80 | 0.254201 | 0.745799 |
| 0.85 | 0.288078 | 0.711922 |
| 0.90 | 0.32772 | 0.67228 |
| 0.95 | 0.378701 | 0.621299 |
| 1.00 | 0.500000 | 0.500000 |

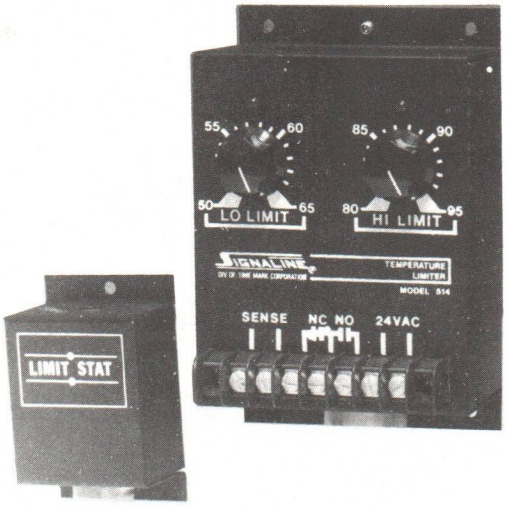
## CHART 2

### KW MULTIPLIERS TO DETERMINE CAPACITOR KILOVARS REQUIRED FOR POWER-FACTOR CORRECTION

| Original Power Factor | Corrected Power Factor | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.80 | 0.81 | 0.82 | 0.83 | 0.84 | 0.85 | 0.86 | 0.87 | 0.88 | 0.89 | 0.90 | 0.91 | 0.92 | 0.93 | 0.94 | 0.95 | 0.96 | 0.97 | 0.98 | 0.99 | 1.0 |
| 0.50 | 0.982 | 1.008 | 1.034 | 1.060 | 1.086 | 1.112 | 1.139 | 1.165 | 1.192 | 1.220 | 1.248 | 1.276 | 1.306 | 1.337 | 1.369 | 1.403 | 1.440 | 1.481 | 1.529 | 1.589 | 1.732 |
| 0.51 | 0.937 | 0.962 | 0.989 | 1.015 | 1.041 | 1.067 | 1.094 | 1.120 | 1.147 | 1.175 | 1.203 | 1.231 | 1.261 | 1.292 | 1.324 | 1.358 | 1.395 | 1.436 | 1.484 | 1.544 | 1.687 |
| 0.52 | 0.893 | 0.919 | 0.945 | 0.971 | 0.997 | 1.023 | 1.050 | 1.076 | 1.103 | 1.131 | 1.159 | 1.187 | 1.217 | 1.248 | 1.280 | 1.314 | 1.351 | 1.392 | 1.440 | 1.500 | 1.643 |
| 0.53 | 0.850 | 0.876 | 0.902 | 0.928 | 0.954 | 0.980 | 1.007 | 1.033 | 1.060 | 1.088 | 1.116 | 1.144 | 1.174 | 1.205 | 1.237 | 1.271 | 1.308 | 1.349 | 1.397 | 1.457 | 1.600 |
| 0.54 | 0.809 | 0.835 | 0.861 | 0.887 | 0.913 | 0.939 | 0.966 | 0.992 | 1.019 | 1.047 | 1.075 | 1.103 | 1.133 | 1.164 | 1.196 | 1.230 | 1.267 | 1.308 | 1.356 | 1.416 | 1.559 |
| 0.55 | 0.769 | 0.795 | 0.821 | 0.847 | 0.873 | 0.899 | 0.926 | 0.952 | 0.979 | 1.007 | 1.035 | 1.063 | 1.093 | 1.124 | 1.156 | 1.190 | 1.227 | 1.268 | 1.316 | 1.376 | 1.519 |
| 0.56 | 0.730 | 0.756 | 0.782 | 0.808 | 0.834 | 0.860 | 0.887 | 0.913 | 0.940 | 0.968 | 0.996 | 1.024 | 1.054 | 1.085 | 1.117 | 1.151 | 1.188 | 1.229 | 1.277 | 1.337 | 1.480 |
| 0.57 | 0.692 | 0.718 | 0.744 | 0.770 | 0.796 | 0.822 | 0.849 | 0.875 | 0.902 | 0.930 | 0.958 | 0.986 | 1.016 | 1.047 | 1.079 | 1.113 | 1.150 | 1.191 | 1.239 | 1.299 | 1.442 |
| 0.58 | 0.655 | 0.681 | 0.707 | 0.733 | 0.759 | 0.785 | 0.812 | 0.838 | 0.865 | 0.893 | 0.921 | 0.949 | 0.979 | 1.010 | 1.042 | 1.076 | 1.113 | 1.154 | 1.202 | 1.262 | 1.405 |
| 0.59 | 0.619 | 0.645 | 0.671 | 0.697 | 0.723 | 0.749 | 0.776 | 0.802 | 0.829 | 0.857 | 0.885 | 0.913 | 0.943 | 0.974 | 1.006 | 1.040 | 1.077 | 1.118 | 1.166 | 1.226 | 1.369 |
| 0.60 | 0.583 | 0.609 | 0.635 | 0.661 | 0.687 | 0.713 | 0.740 | 0.766 | 0.793 | 0.821 | 0.849 | 0.877 | 0.907 | 0.938 | 0.970 | 1.004 | 1.041 | 1.082 | 1.130 | 1.190 | 1.333 |
| 0.61 | 0.549 | 0.575 | 0.601 | 0.627 | 0.653 | 0.679 | 0.706 | 0.732 | 0.759 | 0.787 | 0.815 | 0.843 | 0.873 | 0.904 | 0.936 | 0.970 | 1.007 | 1.048 | 1.096 | 1.156 | 1.299 |
| 0.62 | 0.516 | 0.542 | 0.568 | 0.594 | 0.620 | 0.646 | 0.673 | 0.699 | 0.726 | 0.754 | 0.782 | 0.810 | 0.840 | 0.871 | 0.903 | 0.937 | 0.974 | 1.015 | 1.063 | 1.123 | 1.266 |
| 0.63 | 0.483 | 0.509 | 0.535 | 0.561 | 0.587 | 0.613 | 0.640 | 0.666 | 0.693 | 0.721 | 0.749 | 0.777 | 0.807 | 0.838 | 0.870 | 0.904 | 0.941 | 0.982 | 1.030 | 1.090 | 1.233 |
| 0.64 | 0.451 | 0.474 | 0.503 | 0.529 | 0.555 | 0.581 | 0.608 | 0.634 | 0.661 | 0.689 | 0.717 | 0.745 | 0.775 | 0.806 | 0.838 | 0.872 | 0.909 | 0.950 | 0.998 | 1.068 | 1.201 |
| 0.65 | 0.419 | 0.445 | 0.471 | 0.497 | 0.523 | 0.549 | 0.576 | 0.602 | 0.629 | 0.657 | 0.685 | 0.713 | 0.743 | 0.774 | 0.806 | 0.840 | 0.877 | 0.918 | 0.966 | 1.026 | 1.169 |
| 0.66 | 0.388 | 0.414 | 0.440 | 0.466 | 0.492 | 0.518 | 0.545 | 0.571 | 0.598 | 0.626 | 0.654 | 0.682 | 0.712 | 0.743 | 0.775 | 0.809 | 0.846 | 0.887 | 0.935 | 0.995 | 1.138 |
| 0.67 | 0.358 | 0.384 | 0.410 | 0.436 | 0.462 | 0.488 | 0.515 | 0.541 | 0.568 | 0.596 | 0.624 | 0.652 | 0.682 | 0.713 | 0.745 | 0.779 | 0.816 | 0.857 | 0.905 | 0.965 | 1.108 |
| 0.68 | 0.328 | 0.354 | 0.380 | 0.406 | 0.432 | 0.458 | 0.485 | 0.511 | 0.538 | 0.566 | 0.594 | 0.622 | 0.652 | 0.683 | 0.715 | 0.749 | 0.786 | 0.827 | 0.875 | 0.935 | 1.078 |
| 0.69 | 0.299 | 0.325 | 0.351 | 0.377 | 0.403 | 0.429 | 0.456 | 0.482 | 0.509 | 0.537 | 0.565 | 0.593 | 0.623 | 0.654 | 0.686 | 0.720 | 0.757 | 0.798 | 0.846 | 0.906 | 1.049 |
| 0.70 | 0.270 | 0.296 | 0.322 | 0.348 | 0.374 | 0.400 | 0.427 | 0.453 | 0.480 | 0.508 | 0.536 | 0.564 | 0.594 | 0.625 | 0.657 | 0.691 | 0.728 | 0.769 | 0.817 | 0.877 | 1.020 |
| 0.71 | 0.242 | 0.268 | 0.294 | 0.320 | 0.346 | 0.372 | 0.399 | 0.425 | 0.452 | 0.480 | 0.508 | 0.536 | 0.566 | 0.597 | 0.629 | 0.663 | 0.700 | 0.741 | 0.789 | 0.849 | 0.992 |
| 0.72 | 0.214 | 0.240 | 0.266 | 0.292 | 0.318 | 0.344 | 0.371 | 0.397 | 0.424 | 0.452 | 0.480 | 0.508 | 0.538 | 0.569 | 0.601 | 0.635 | 0.672 | 0.713 | 0.761 | 0.821 | 0.964 |
| 0.73 | 0.186 | 0.212 | 0.238 | 0.264 | 0.290 | 0.316 | 0.343 | 0.369 | 0.396 | 0.424 | 0.452 | 0.480 | 0.510 | 0.541 | 0.573 | 0.607 | 0.644 | 0.685 | 0.733 | 0.793 | 0.936 |
| 0.74 | 0.159 | 0.185 | 0.211 | 0.237 | 0.263 | 0.289 | 0.316 | 0.342 | 0.369 | 0.397 | 0.425 | 0.453 | 0.483 | 0.514 | 0.546 | 0.580 | 0.617 | 0.658 | 0.706 | 0.766 | 0.909 |
| 0.75 | 0.132 | 0.158 | 0.184 | 0.210 | 0.236 | 0.262 | 0.289 | 0.315 | 0.342 | 0.370 | 0.398 | 0.426 | 0.456 | 0.487 | 0.519 | 0.553 | 0.590 | 0.631 | 0.679 | 0.739 | 0.882 |
| 0.76 | 0.105 | 0.131 | 0.157 | 0.183 | 0.209 | 0.235 | 0.262 | 0.288 | 0.315 | 0.343 | 0.371 | 0.399 | 0.429 | 0.460 | 0.492 | 0.526 | 0.563 | 0.604 | 0.652 | 0.712 | 0.855 |
| 0.77 | 0.079 | 0.105 | 0.131 | 0.157 | 0.183 | 0.209 | 0.236 | 0.262 | 0.289 | 0.317 | 0.345 | 0.373 | 0.403 | 0.434 | 0.466 | 0.500 | 0.537 | 0.578 | 0.626 | 0.685 | 0.829 |
| 0.78 | 0.052 | 0.078 | 0.104 | 0.130 | 0.156 | 0.182 | 0.209 | 0.235 | 0.262 | 0.290 | 0.318 | 0.346 | 0.376 | 0.407 | 0.439 | 0.473 | 0.510 | 0.551 | 0.599 | 0.659 | 0.802 |
| 0.79 | 0.026 | 0.052 | 0.078 | 0.104 | 0.130 | 0.156 | 0.183 | 0.209 | 0.236 | 0.264 | 0.292 | 0.320 | 0.350 | 0.381 | 0.413 | 0.447 | 0.484 | 0.525 | 0.573 | 0.633 | 0.776 |
| 0.80 | 0.000 | 0.026 | 0.052 | 0.078 | 0.104 | 0.130 | 0.157 | 0.183 | 0.210 | 0.238 | 0.266 | 0.294 | 0.324 | 0.355 | 0.387 | 0.421 | 0.458 | 0.499 | 0.547 | 0.609 | 0.750 |
| 0.81 | | 0.000 | 0.026 | 0.052 | 0.078 | 0.104 | 0.131 | 0.157 | 0.184 | 0.212 | 0.240 | 0.268 | 0.298 | 0.329 | 0.361 | 0.395 | 0.432 | 0.473 | 0.521 | 0.581 | 0.724 |
| 0.82 | | | 0.000 | 0.026 | 0.052 | 0.078 | 0.105 | 0.131 | 0.158 | 0.186 | 0.214 | 0.242 | 0.272 | 0.303 | 0.335 | 0.369 | 0.406 | 0.447 | 0.495 | 0.555 | 0.698 |
| 0.83 | | | | 0.000 | 0.026 | 0.052 | 0.079 | 0.105 | 0.132 | 0.160 | 0.188 | 0.216 | 0.246 | 0.277 | 0.309 | 0.343 | 0.380 | 0.421 | 0.469 | 0.529 | 0.672 |
| 0.84 | | | | | 0.000 | 0.026 | 0.053 | 0.079 | 0.106 | 0.134 | 0.162 | 0.190 | 0.220 | 0.251 | 0.283 | 0.317 | 0.354 | 0.395 | 0.443 | 0.503 | 0.646 |
| 0.85 | | | | | | 0.000 | 0.027 | 0.053 | 0.080 | 0.108 | 0.136 | 0.164 | 0.194 | 0.225 | 0.257 | 0.291 | 0.328 | 0.369 | 0.417 | 0.477 | 0.620 |
| 0.86 | | | | | | | 0.000 | 0.026 | 0.053 | 0.081 | 0.109 | 0.137 | 0.167 | 0.198 | 0.230 | 0.264 | 0.301 | 0.342 | 0.390 | 0.450 | 0.593 |
| 0.87 | | | | | | | | 0.000 | 0.027 | 0.055 | 0.083 | 0.111 | 0.141 | 0.172 | 0.204 | 0.238 | 0.275 | 0.316 | 0.364 | 0.424 | 0.567 |
| 0.88 | | | | | | | | | 0.000 | 0.028 | 0.056 | 0.084 | 0.114 | 0.145 | 0.177 | 0.211 | 0.248 | 0.289 | 0.337 | 0.397 | 0.540 |
| 0.89 | | | | | | | | | | 0.000 | 0.028 | 0.056 | 0.086 | 0.117 | 0.149 | 0.183 | 0.220 | 0.261 | 0.309 | 0.369 | 0.512 |
| 0.90 | | | | | | | | | | | 0.000 | 0.028 | 0.058 | 0.089 | 0.121 | 0.155 | 0.192 | 0.233 | 0.281 | 0.341 | 0.484 |
| 0.91 | | | | | | | | | | | | 0.000 | 0.030 | 0.061 | 0.093 | 0.127 | 0.164 | 0.205 | 0.253 | 0.313 | 0.456 |
| 0.92 | | | | | | | | | | | | | 0.000 | 0.031 | 0.063 | 0.097 | 0.134 | 0.175 | 0.223 | 0.283 | 0.426 |
| 0.93 | | | | | | | | | | | | | | 0.000 | 0.032 | 0.066 | 0.103 | 0.144 | 0.192 | 0.252 | 0.395 |
| 0.94 | | | | | | | | | | | | | | | 0.000 | 0.034 | 0.071 | 0.112 | 0.160 | 0.220 | 0.363 |
| 0.95 | | | | | | | | | | | | | | | | 0.000 | 0.037 | 0.079 | 0.126 | 0.186 | 0.329 |
| 0.96 | | | | | | | | | | | | | | | | | 0.000 | 0.041 | 0.089 | 0.149 | 0.292 |
| 0.97 | | | | | | | | | | | | | | | | | | 0.000 | 0.048 | 0.108 | 0.251 |
| 0.98 | | | | | | | | | | | | | | | | | | | 0.000 | 0.060 | 0.203 |
| 0.99 | | | | | | | | | | | | | | | | | | | | 0.000 | 0.143 |
| | | | | | | | | | | | | | | | | | | | | | 0.000 |

## Model 514

# TEMPERATURE LIMITER




- Automatic High & Low Limits
- Complete With Limit-Stat
- Limits Within 2° F
- All Solid-State Circuitry

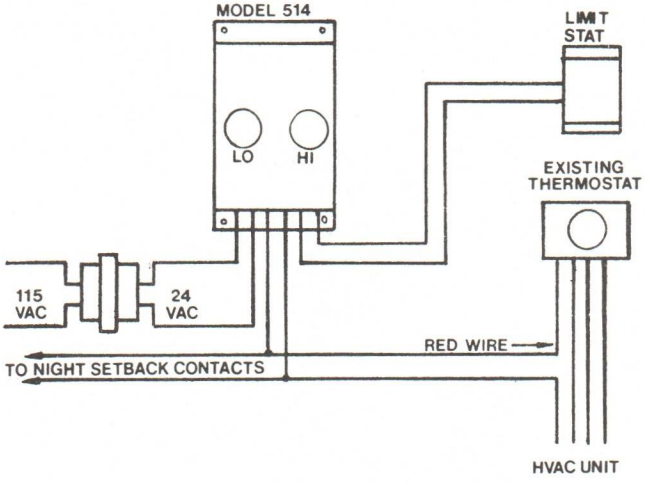
## DESCRIPTION

The Model 514 was designed for use where thermostats are being set back during non-business hours, and high and low temperature limits need to be maintained. The output contacts are normally connected directly into the night setback and thermostat wiring as shown in the application drawing. The Model 514 is usually used with an external time clock or existing night setback systems. Output contacts will transfer if the temperature rises above or drops below the preset limits. A temperature sensor is supplied with each Model 514. Lower limit range is 50° F to 65° F, and upper limit range is 80° F to 95° F.

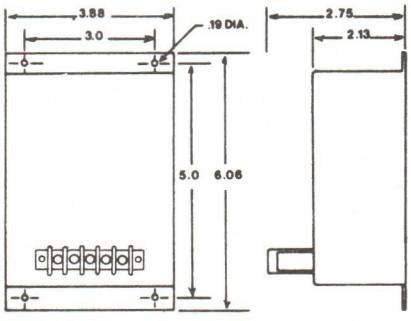
## SPECIFICATIONS

| | |
|---|---|
| Supply Voltage | 24 VAC, 50 / 60 Hz |
| Power Required | 1 Watt Max. |
| Contact Type | SPDT |
| Contact Rating | 2 amps at 120 VAC |
| Transient Protection | 2500 VRMS / 10 ms |
| Temperature Range | 32° F to 130° F |
| Case Material | 20 ga. C.R.S. |

## APPLICATION




## DIMENSIONS





SIGNALINE
DIV OF TIME MARK CORPORATION

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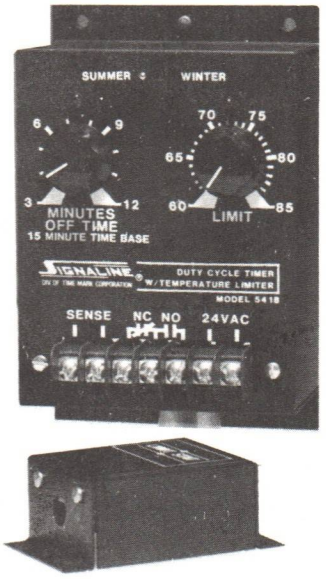
| DRAWING NUMBER: | © Copyright TMC 1984 |

**Model 541**

# DUTY CYCLE TIMER

## WITH TEMPERATURE LIMITER




- Temp Limiter Overrides Cycling During Peak Times
- Indicator Lights Show Load Shed and Over Temp Limit
- Includes Temperature Sensor
- Two Models Available

## DESCRIPTION

The Model 541A is designed to duty cycle the compressor in refrigerated boxes on a 15 minute time base. The unit has an adjustable load off-time of 3 to 12 minutes and an indicator which lights to show that the load is off (relay energized). If the temperature in the box rises above the temperature set on the "limit" control, duty cycling is interrupted and the compressor runs continuously until the temperature drops 4° F below the set point. Duty cycling then resumes.

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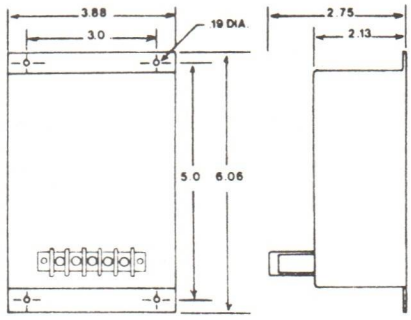
The Model 541B is designed to control a thermostat, thereby controlling heating or air conditioning. Like the 541A, the 541B has a 15 minute time base adjustable from 3 to 12 minutes of off time. In the "summer" mode a rise in temperature overrides the cycling, turning the air conditioning on until the temperature drops below the set point. In the "winter" mode a drop in temperature overrides the cycling, turning on heating until the temperature rises above the set point. Special timing or temperature ranges are available on request.

## DIMENSIONS




## SPECIFICATIONS

| | |
|---|---|
| Supply Voltage | 24 VAC, 50-400 Hz |
| Power Consumption | 1 Watt Max. |
| Transient Protection | 2500 V/10 ms |
| Contacts | SPST, 2 AMP At 115 VAC |
| Time Base | 15 Min. ±2% |
| Adjustable Off Time | 3-12 Min. ±5% |
| Temperature Range | 541A: 25° to 50°F |
| | 541B: 60° to 85°F |
| Sense Input | Limit Stat (Incl.) |
| Dead Band | 541A: 4° |
| | 541B: ±2° |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| | |
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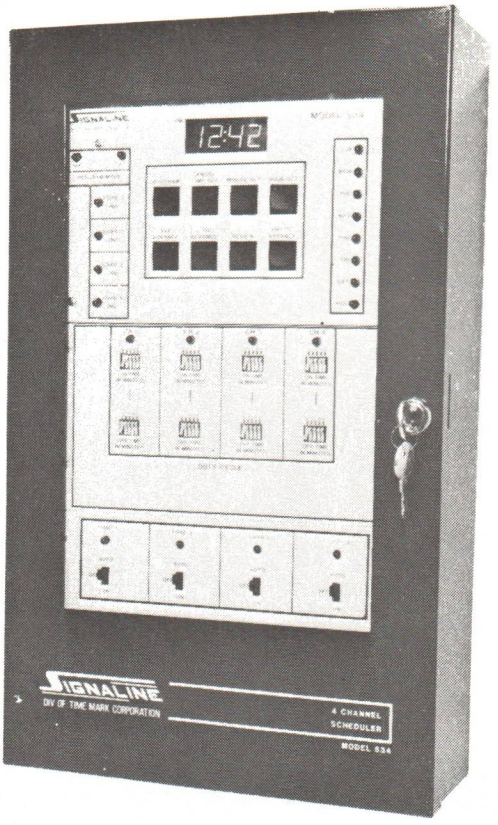
**MODEL 534**

# 4 CHANNEL SCHEDULER




- 4 Independently Programable Channels
- 148 Programable Locations
- Battery Backup
- Optional Duty Cycling Of Loads
- Optional Demand Load Control
- Easy Programing
- Ideal For Small To Medium Applications

## DESCRIPTION

The Model 534 is the heart of the SIGNALINE modular energy management system. The microprocessor-based four circuit clock provides low cost time-of-day control of HVAC systems, security systems and indoor/outdoor lighting. It can also be programmed to schedule motors, fans, pumps or other control devices, duty cycle the loads during their "on" schedule, and shed loads on a priority basis if the power demand exceeds preset limits.

Each channel of the Model 534 is fully programmable for seven days. In addition, as many as six holidays can be programmed up to six days in advance. The clock has 148 programmable memory locations (74 on/off pairs) which can be apportioned among the four channels in any combination. For example, each channel can be programmed for 3 on/off pairs per day, Monday through Friday, with 14 left for holidays, weekends, or additional programming on selected weekdays. While loads are programmed "on", they may be duty cycled with the optional Duty Cycling panel. Both of the "on" and "off" cycles are adjustable to 15.5 minutes. Another option, Demand Load Shedding, allows each load to be shed on a priority basis as electical power usage exceeds a predetermined limit. Demand control is operational when loads are scheduled on, and each load can be duty cycled when not shed.

Eight multifunction programming buttons make the 534 simple to program. During programming, LED indicators show the program mode, load and day being programmed. In the operating mode, indicators show the time-of-day, load status and day-of-week. Override switches allow manual control of each load. A battery back-up system preserves the memory and maintains the correct time-of-day, during a power outage, for at least six hours. Upon reapplication of power, all loads return to their programmed status.

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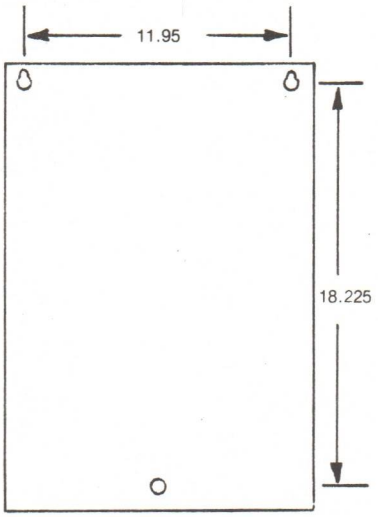
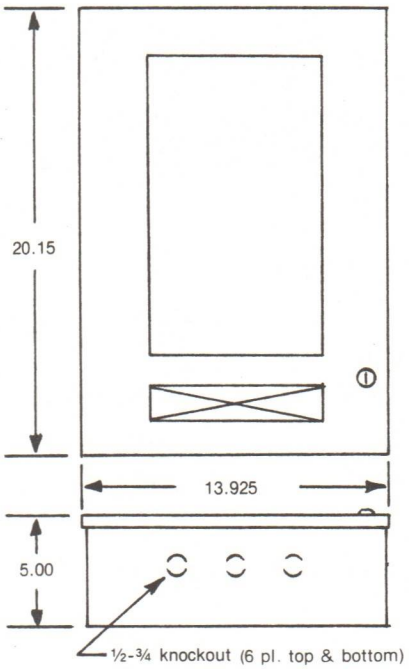
# DIMENSIONS

MOUNTING




# SPECIFICATIONS

## MODEL 534

### ELECTRICAL
Operating Voltage ..... 24 VAC, 120 VAC
Frequency ..... 50 / 60 Hz
Power ..... 16 W

### BATTERY
Type ..... 6 VDC Gel, Installed
Back- Up Duration ..... 6 Hours Min.

### OUTPUT
Contacts ..... SPDT Electromechanical
Rating ..... 360 VA, Class 2 Power

### OPERATION
Program Capacity ..... 148 Memory Locations (74 On/ Off Pairs)
Programming ..... 1 Minute Intervals
Display ..... 0.5 LED With PM Indicator
Accuracy ..... 5 Sec/ Month

### ENVIRONMENTAL
Operating Temperature ..... -20° to 60° C
Storage Temperature ..... -30° to 85° C

### MECHANICAL
Case ..... 20 Ga. Steel
Finish ..... Beige With Brown Trim

## OPTIONAL BOARDS

### DUTY CYCLER
Power ..... Cable Connection To Main 534 Board
Operating Channels ..... Four
On Time / Off Time ..... 15.5 Minutes Max. 30 Second Intervals
Timing Selection ..... via 5 binary coded switches

### DEMAND LOAD CONTROL
Function ..... Demand Control And Duty Cycle
Power ..... Cable Connection to Main 534 Board
Operating Channels ..... Four
Input ..... 0 - 15 VAC From Current Transducer
Calibration Reference ..... 0 - 10 VDC Proportional To Power Use

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